Max. 5 keywords to describe the project activity.

root growth; nutrient efficiency; nutrient recirculation; compost; baking quality;

A11. Short project description/summary on objectives, activities, and expected results, both in Danish and English language (max 1500 characters, incl. spaces for both languages)

Project summary:

With plans to phase out manure import from conventional farms, it will become increasingly difficult to secure plant nutrients for organic crops. In the RoCo project we will address this problem through three approaches: 1) study variation in root growth and root hair formation among cultivars of wheat, onion and lettuce, to identify superior cultivars and critical root traits which can be used as breeding objectives for new cultivars for organic farming, 2) study recirculation of urban nutrient sources through composting, to make them good fertilizers and study what make them acceptable for consumers and organic farmers, and 3) with wheat baking quality as example, study whether we can solve some of the quality problems caused by nutrient limitation by the way we use the product rather than by increasing nutrient supply in the field.

We will do research within all three main themes and interactions between them, i.e. whether genotypes with superior root traits are better at using nutrients from the composts, and whether some wheat genotypes vary in their ability to utilize compost to achieve god baking quality. We will develop and test improved compost products, and develop bread baking including the use of natural additives to enhance backing quality. Demonstration activities will be related to all parts of the project. Composts will be tested for different wheat types at organic farms and differences in root traits or baking quality will be demonstrated at open field days.

Projekt resume:

Med målet om at udfase brugen af konventionel husdyrgødning vil det blive sværere at sikre næringsstoffer til

økologiske afgrøder. I RoCo projektet vil vi bidrage til løsningen af problemet på 3 måder: 1) Vi vil studere rodvækst hos sorter af hvede, løg og salat, for at finde sorter med gode rodegenskaber og identificere vigtige rodegenskaber til brug ved forædling af sorter til økologisk jordbrug, 2) arbejde med kompostering og recirkulering af næringsstofkilder fra byerne, og hvad der kan gøre gødningerne acceptable for forbrugere og økologiske landmænd, og 3) med bagekvalitet af hvede som eksempel vil vi undersøge om problemer med produktkvalitet der skyldes næringsstofbegrænsninger kan løses ved at ændre den måde vi bearbejder produkterne på, frem for ved at øge næringsstofforsyningen i marken.

Vi vil lave forskning inden for alle 3 hovedtemaer og interaktionerne imellem dem, f.eks. om genotyper med bedre rodvækst også er bedre til at udnytte næringsstoffer fra komposten, og om der er forskel i hvedesorternes evne til at udnytte kompost som gødningskilde til at opnå en høj bagekvalitet. Vi vil udvikle og teste kompostprodukter, og udvikle brødbagning bl.a. ved tilsætning af naturlige additiver der kan fremme bagningen. Alle dele af projektet vil indgå i demonstration, bl.a. ved forsøgsdyrkning af hvede og grønsager gødet med kompost på økologiske landbrug, og ved demonstration af forhold som forskelle i rodvækst, rodhårsdannelse eller bagekvalitet ved markvandringer m.v.

A12. Project description

(All parts of A12 must be filled out. Use "Garamond" as font, and font size 12, single spaced)

A12.1 The project objectives (2-3 lines). The main objective is to help organic farming increase its nutrient use efficiency and to become independent of import of nutrients from conventional farming. We will do this through improved plant material, improved nutrient recycling and methods to live with lower nutrient availability.

A12.2 The background and idea (hypotheses) incl. the national and international "state of art" and incl. references relevant for the section (max. ¾ page). Current crop cultivars have been breed at conventional conditions of high nutrient availability, and thus not selected to use nutrients well under conditions of low nutrient availability. Organic cultivars should be adapted to future low nutrient conditions in organic farming. Such cultivars should explore the soil efficiently for nutrients. Cultivars of wheat and barley with long root hairs have a much increased capacity for uptake of soil phosphorus (Gahoonia and Nielsen 1996; Gahoonia et al. 1992) and give high yields under nutrient limiting conditions (Gahoonia et al. 1999). To exploit soil nitrogen effectively crop roots should reach deep into the subsoil (Acuna et al., 2010; Lynch, 2007; Thorup-Kristensen, 2006a; Thorup-Kristensen et al., 2009), and for all nutrients rapid root colonization of the topsoil during early critical growth stages is important. For row crops such as vegetables fast horizontal root growth is critical (Thorup-Kristensen, 2006b). In this project we will study variation in root hair and root growth traits among current and older cultivars of wheat, onion and lettuce, to identify superior cultivars which may be grown in organic production or used in the breeding of future cultivars. We will test the hypothesis that the cultivars with superior root characteristics grow better at low nutrient availability and are better able to use nutrients from composts.

In order to maintain sustainability, at least part (30-50%) of the P, K and micronutrient supply that is currently imported with conventional manure must be substituted with other sources. This requires both development and demonstration of alternative sources of nutrient supply. We will use focus group studies to examine the farmer and consumer acceptance of alternative sources (Lassen and Sandoe, 2009) and find ways to secure their successful implementation. The partner 'Økologisk Landsforening' will subsequently adapt the

current regulation in order to enable at partial substitution of nutrients currently supplied from conventional manure. By testing composts and related products that may be used with greater precision in the field on selected vegetables and wheat, we will attempt to demonstrate acceptable yields and quality may be obtained, particularly with respect to baking quality of wheat.

Baking quality includes several quality aspects such as the quality of the flour (gluten protein quality and composition, starch and amylase activity), rheology and gluten network of the dough and finally the sensory quality, especially textural parameters, volume and structure of the bread (Tronsmo 2002). The gluten content and quality of wheat is determined by the genetic background as well as the environmental factors (Luo et al. 2000). High gluten content in wheat is typically achieved by high fertilizer N supply, this is already difficult in organic production (Thomsen et al. 2008), and will become even more so without access to manure from conventional farming. However, several natural products may be used to improve the baking result (Boz et al. 2010) of wheat with low gluten content, e.g. malt flour which contain important enzymes from the malting process, or rosehip which contain ascorbic acid (Bonet et al. 2006). We will test the hypothesis that by cultivar choice and by adding selected natural products to the flour, high quality bread can be produced from wheat grown at relatively low nitrogen availability.

For references, see Appendix 1.

A12.3 The projects contribution to solving important challenges for the organic food, agriculture and aquaculture sectors and the general political goals regarding food, agribusiness and environment as expressed in the governments Green Growth programme. Including an explanation of the projects focus on respectively the entire product/value chain or selected parts here of (e.g. primary production, processing, trade and transport) – max. ½ page. The project will contribute to reduce problems with limited nutrient availability in organic farming, helping to improve yield and/or quality of organic crops. This will help reduce production costs and hence the need for a substantial premium price for organic products, which in turn will increase the market share of organic products. The methods we suggest will focus on improved management and recycling of nutrients and the effects of limited nutrient availability, rather than on increased nutrient import, and will thereby also contribute to reducing nutrient losses to the environment. We will address the organic farming goals of improved nutrient recirculation from urban waste to agriculture, including societal acceptability, and the goal of working on crop genotypes better adapted to the conditions of organic farming.

Through the project we will work with different parts of the production chain. In the field crop production we will work on better adapted crop cultivars with improved root growth characteristics, allowing improved crop production at limited nutrient availability. The study will focus on wheat for bread baking and two vegetable crops, in order to help organic farming to develop the production of these high value crops.

We will work with production of acceptable organic fertilizers for organic farming based on urban waste, both in terms of the attitudes of consumers and organic farmers towards using such nutrient sources for food crop production, and in terms of the possibilities for commercial scale production of such organic fertilizers.

We will focus on the processing part of the production chain. One of the major challenges is that organically grown wheat typically has low protein content caused by restricted nitrogen availability, a protein content which is too low for optimal baking quality. Attempts have been made to improve the protein content in organic wheat during crop management, with some success, but we believe that the above measures have a scope for also improving protein content and quality. Additionally we will focus on options to improve the baking result of wheat with low protein content by introducing natural additives in the baking process. This can help promote both production of the high quality bread wheat crop in organic farming, and benefit mills and bakery companies in their attempt to enhance the market for organic bread.

A12.4 The projects innovative value, relevance and effect including the specific barriers and development potential for the organic sector the project will solve and/or support (max. ½ page).

Within the RoCo project we will work with three innovative approaches to help organic farming overcome barriers of limited nutrient availability. We will work with improved plant genetic material, with improved and acceptable recirculation of plant nutrients from urban areas and with managing wheat baking quality problems due to limited supply of especially nitrogen.

It is known that plant genotypes differ in root growth and root system efficiency, but this knowledge has rarely been used for farming in practice. The present approach of combining root development studies with alternative, slow release nutrient sources is novel. We will study important variation in root proliferation and nutrient scavening among current and old genotypes of three crop species, and develop new methods for use in breeding of cultivars suitable for organic farming.. Current cultivars found to have superior root traits can be used directly by organic farmers, and the general variability we find will show the potential for organic crop breeding for better nutrient efficieny of crops.

The concept of recycling nutrients and organic matter from urban to rural areas is old, but it has always constituted a dilemma for organic farming. While recycling of urban waste products is an ideal it is generally not perceived as acceptable for organic farming. The present application of user- and consumer-driven development of specifically designed and publically acceptable, uncontaminated organic compost types of urban origin is a novel approach to this problem, which has the potential to affect regulations of organic production.

Agronomic solutions to produce organic wheat with high protein content have been studied for years with some progress, but the problem has not been solved. We will study the effect of compost fertilization on wheat quality of wheat genotypes with different root growth and baking characteristics. As a novel approach we will also work with the baking process, looking for solutions in natural additives, e.g. malting flour which contain compounds or enzymes that enhance baking quality.

The whole-chain approach will allows us to develop improved crop management systems, allowing organic farming to become less dependent on external inputs and the organic bread producers to produce bread with improved quality.

A12.5 Description of activities, methods and expected results divided into work packages with clear denotion of which activity the applicant consider to be either Research, Development or Demonstration. The coherence between work packages must be clearly described and the relation between activities and the tables with milestones and deliverables must be logical and consistent. Moreover, the primary target groups should be clearly identified with a description of how these will be met by the project (max. 1 page per WP and max. 3 pages in total).

WP1 – Roots and nutrient uptake efficiency – Res & Dev.

Aim: To study variation in important crop root traits, to identify genotypes with superior root traits, and study how this may improve their ability to grow under conditions of low nutrient availability and use nutrients from composts. We will compare current cultivars and compare them to older cultivars to study whether important root characteristics have been lost in modern cultivars. We will study wheat as a major cereal crops and onion and lettuce as examples of high value vegetable crops where special challenges to the root system exist due to the row structure of the crops.

Methods and Activities: We will identify current cultivars of wheat, lettuce and onion and older cultivars from gene banks and other sources. For wheat the old cultivars will include both common wheat and spelt and emmer cultivars. We will screen the cultivars for three main parameters: Ability to colonize deep soil layers, ability to spread roots horizontally and colonize topsoil layers during early growth, and root hair formation. Screening of a number of genotypes will be made in transparent tubes in the greenhouse. Selected genotypes will be studied under field and semi-field conditions with minirhizotron technique, and their ability to grow and acquire nutrients from composts and soils with low nutrient availability and composts will be studied. Relevant wheat, onion and lettuce genotypes will be selected for the field studies in WP3.

Results and outcome:

1. Knowledge on functional root trait variation among current and old genotypes of wheat, lettuce and onion, and whether variation exists among current cultivars directly applicable by farmers.
2. Protocol for simple testing of root traits to help identify cultivars suited for organic farming

3. Field testing in interaction with composts

WP2 - Acceptable, high quality alternative nutrient sources for organic farming – Dev & Demo
Aim: To develop and demonstrate compost types for organic farming based on urban nutrient sources. To use the different qualities of urban waste products for compost aimed at specific purposes, i.e. high value composts for fertilizer placement in vegetable crops or less nutrient rich composts mainly for soil improvement with limited and mostly long term fertilizer effects.
Methods and activities: Development of high quality, compost-based organic fertilizer involves the production of compost that may be placed accurately in the field at a certain proximity to the plants for improved nutrient availability. KomTek Miljø A/S will produce novel compost products in collaboration with researchers, based on food waste from larger organic food cantinas. Other, more pragmatic urban and industrial nutrient sources may be included in separate trials, i.e. garden park waste, source separated household waste and bioenergy sludges. At the KU experimental farm in Taastrup The Nutrient Depletion trials, which in some treatments has not received P or K fertilizers over the past 40 years, will be utilised for testing and demonstration of the alternative nutrient sources, in combinations with testing of nutrient efficient crop genotypes identified in WP1. The facility also includes treatments, which has received manure applications as the sole nutrient input for the past 15 years, and hence will be relevant for studies of improved utilization of organic nutrient sources.
Results and outcome:
1. A high quality, semi-granular compost suitable for row placement at seeding will be developed and tested
2. Compost-based seedling-blocks will be developed and tested for transplanted vegetable cultures
3. Demonstration of the interaction between alternative nutrient sources, and wheat yield and baking quality will be carried out

WP3 – Influence of alternative nutrient sources on crops and product quality – Res, Dev & Demo
Aim: the aim is to evaluate how different organic manure (types of compost and slurry) and different wheat cultivars affect the backing quality of wheat bread. The aim is also to find appropriate alternatives that can be used in the baking process and that counteract the poor protein quality of organic wheat.
Methods and Activities: In 2011 wheat, onion and lettuce cultivars will be screened (see WP1). Four cultivars of onion and lettuce will be selected for field testing at "Årstiderne". Five wheat cultivars will be selected for the field trials in 2012 and 2013, where they will be grown with different types of organic composts produced by KomTek in WP2, an organic slurry and a non-fertilized control. The field trials will be carried out the growing seasons of 2012 and 2013 at two organic farms each year. The trials with wheat, lettuce and onion will also be used for demonstration at "open field days".

After harvesting, the protein content in the wheat samples will be determined. At AU-IFK, the wheat samples will be milled to flour and baking test will be conducted for the different samples in both years. The baking quality of the flour from the different samples will be measured by determination of the gluten content. Determination of the bread quality includes determination of the loaf volume, instrumental measurement of texture and sensory evaluation of the samples using a trained sensory panel. A small consumer preference test will be carried out in 2013 for selected bread samples.

Furthermore, use of alternative ingredients for enhancing baking quality of low protein organic wheat will be studied during bread manufacturing in 2012 at AU-IFK in cooperation with Lantmännen R&D. The ingredients for improvement of the baking quality of wheat include e.g. malt flour, rosehip and vital gluten and natural occurring enzymes form flour. The studies will be carried out on two wheat cultivars from the growing trials, - selected to have high and low protein content respectively. The gluten in the dough, the volume, texture and the sensory quality of the bread from will be measured.
Expected results:
1. Response of onion and lettuce cultivars to composts have been determined
2. The effect of different compost on the baking quality of wheat cultivars have been studied
3. Consumers' preference for bread from compost fertilized wheat cultivars

4. The effect of alternative ingredients to improve the baking quality of organic wheat have been studied and promising ingredients identified

WP4 – Optimisation of rotations with improved root growth and alternative nutrient sources – Dev & Demo
Aim: To give organic advisers and farmers insight and tools for improved nutrient management in organic farming without import of manure from conventional farms. Focus will be on implementing the results of the RoCo project and of previous FØJO projects on nutrient management in stock-less organic farming systems in future advice for organic farmers. Main themes will management of P and K based on urban and other alternative sources, and use of catch crops, green manures and improved crop rotation design for improve N management.
Methods and Activities: Presentation of the field demonstrations in WP 3 at meetings and open field days in cooperation with presentations from other WPs. We will prepare new organic farm advice for the period after 2015 when the use of manure from conventional farms is gradually decreased. The guidelines will build on old results and new results from the RoCo project, using the NDICEA program (van den Burgt et al., 2006). All organic advisers shall be trained in using NDICEA, allowing them to develop and test new strategies for organic plant production farms.
Results and outcome:
1. Organic advisers are educated in the program NDICEA
2. The results from WP 1 and WP 3 are presented in guidelines for organic production
3. New guidelines for organic farming when without conventional manure, on how to use alternative nutrient sources, catch crops, green manure crops and optimal crop rotation design.

WP5 – Socially robust alternatives: Perceptions among organic farmers and consumers – Res & Dev
Aim: A future successful implementation of alternative nutrient sources in organic farming depends on acceptance by key stakeholders – thus new strategies must at least be acceptable to farmers and consumers. The aim of this work package is to examine the perceptions of alternative strategies and enable their successful implementation.
Method: Based on a review of existing research into factors influencing consumers' and farmers' perceptions of new technologies like the ones here considered, researchers at FOI/LIFE will carry out 5+5 focus group interviews with Danish organic farmers and consumers of organic products. Participants will be recruited to maximize the variation in perceptions. The interviews will follow interview guides, developed in collaboration with experts from the other WPs. The guides will include an explorative phase uncovering immediate perceptions and a structured phase uncovering perceptions of different possible pre-defined strategies. The interviews will be analyzed and results communicated to the other WPs in the project. Results will be published in a paper submitted to a peer reviewed international journal and will be used by Økologisk Landsforening (Organic Denmark), in their work on developing future regulations of acceptable manure use and sources for Danish organic farmers. Depending on which strategies are prioritized, Økologisk Landsforening will undertake relevant activities to facilitate their successful implementation. This may include information campaigns and consultations with consumer representatives, business and public authorities.
Results and Outcome: The work will result in detailed knowledge about factors influencing consumer as well as farmer perceptions of different alternative nutrient sources. This will help ranking alternative strategies according to their social robustness and thus form a platform for decision making regarding implementation of prioritised strategies. The active participation of OD will help facilitate the implementation of the most socially robust strategies in organic agriculture in Denmark.

WP6 – Project management, stakeholder network and dissemination
In WP6 the task is to organize the project and manage the general aspects of the project, e.g. its dissemination towards the organic sector and the Danish public sector in general.

A steering committee will be formed consisting of one representative of each partner. The steering committee will meet (probably "Skype meetings") at least once a year at the time of status reporting, and meet ad hoc or discuss by e-mail when necessary.

A stakeholder network will be identified consisting of 20-40 stakeholders. Short electronic newsletters will be sent to them 2-4 times a year, to give information on important activities in the project and the public meetings/open field days we arrange, and to encourage them to give feedback to us. The stakeholder network will include magazines hoping that they will write about the project work.

The "project unit" at KU-IJØ will be included to assist communication with the stakeholder network and project partners and collection and organization of information from partners e.g. for status reporting. Meetings for the whole research group of the project will be organized at least three times during the project period.

A12.6 Description of how it will be ensured that the project results can be implemented in practice and perhaps commercialized (max. ½ page). We will ensure that the results can be used by testing them under real production conditions and by the fact that relevant "end users" are directly involved in the project. Further, the network of project stakeholders (See WP6 and A12.9) will be used to present, disseminate and promote the application of the new technologies, both within the Danish organic sector and on the international scene.

The root studies constitute the part of the project where the results may be least directly applicable in the short term, but still we will test whether superior root traits lead to better performance under low nutrient availability at real organic farm conditions. We will also develop a protocol for simplified testing of main root traits of cultivars, which may be used in breeding work or in testing of newly released cultivars for their suitability for organic farming.

The studies on development of compost types from urban waste will be done partly at a commercial composting company. Two organic waste recycling companies participate in the project, allowing them to use the knowledge gained directly in development of their production. Composts will be tested and demonstrated at organic farmers fields by Vindenscenteret for Landbrug. The studies on acceptability of nutrient sources for consumers and organic farmers will be made with Økologisk Landsforening as a project partner, making the results obtained very directly available for them in their work on developing the regulations and methods of organic production.

Studies of wheat baking quality will be made in cooperation with the bakery at Lantmannen securing that the studies made will be relevant in practice, and that results will be obtained in cooperation with a company which can utilize them directly in their production.

A12.7 Description of possibilities for a general utilisation of the results (max. ½ page). There are a few previous examples where significant differences in root traits among crop cultivars have been found. If we find significant differences among current cultivars of wheat, onion and lettuce, this can be used directly by organic farmers. If we find valuable variation in root traits among current or old cultivars, this can be used directly in breeding future cultivars and get a more lasting effect. Well described and simplified methods for testing root traits can be used both in breeding or for testing new cultivars for organic farming, for wheat, onion and lettuce, but also many for many other crop species.

The results on compost development will be directly applicable, as it will be directed at identifying more urban material sources for recycling, and increase the extent to which they are used for organic farming. The work on consumers and organic farmers' attitudes to recirculation of urban nutrient sources can be applied for development of regulations on nutrient management for organic farming in ways which maintain the integrity of organic farming and its acceptance among consumers. Regarding urban nutrient sources which may be deemed unacceptable for organic farming, the work is expected to help pinpoint aspects of the urban

waste collection and treatments systems which must be changed to make the nutrient sources acceptable in the future.

On baking quality the results on specific cultivars and their interaction with compost fertilization can be directly applied, but can also show whether future cultivars should be tested specifically for their ability to produce good quality wheat for baking under low-input organic farming conditions. At small specialized mills and bakeries some methods have been developed to deal with low-gluten wheat from organic farming, but such methods can be difficult to implement at large scale bakeries. The studies we propose on using natural ingredients to improve the baking process may help solve some of these problems, and thereby to allow Danish organic farmers to supply more wheat to the high-value market for bread wheat.

A12.8 Description of the coherence between the research, development and demonstration activities in the project, including involvement of relevant users of the results (max. ½ page). The research aspects of the project are spread across very different topics, from plant roots to compost production to wheat quality and baking. This is done in an attempt to cover relevant subjects for a Danish organic farming sector working to become independent from the import of manure from conventional farms, and to work with the whole production chain. In the field trials we will test and demonstrate the work with plant roots of wheat, onion and lettuce and with compost directly in organic farmers fields. Specifically for wheat we will use the wheat produced in the field trials for studies of baking quality and effects of wheat cultivars and compost fertilization on baking quality. We will prioritize an effort to illustrate also the research aspects of the project at meetings and open field days, presenting as directly as possible cultivar differences in root growth, different compost types and uses, and effects on bread baking results.

Various end users of the results are directly involved in the project. Økologisk Landsforening as well as Videncenter for Landbrug are organizations that play very important roles in developing organic farming in Denmark, they work directly on advice for organic farming and are influential in the process of developing the rules and regulations on organic farming in Denmark. Both organizations represent many members from the organic farming sector, and Økologisk Landsforening also represent processing industries and consumers among their members. Through the participation of KomTek and Solum in the project, companies working with composting urban residues are directly involved in the project, they will contribute their experience and competence within the are to the project, and directly learn from the results of the project. Regarding wheat quality and bread baking, the company Lantmännen R&D will be directly involved in the project, not as a formal partner of the project, but they have commited themselves to play an active role in the project and use own ressources for this (see appendix 3).

Through the field trials two organic farms will be directly involved in the project work, as will the vegetable producers at Aarstiderne A/S (see appendix 4).

Through the Stakeholder network we will work to keep a broader group of end users informed about the work and results of the project, and encourage them to interact with the project group.

A12.9 Project organisation, management and administration (max. ½ page). Due to the size and complexity of the project, its organisation is described as a separate workpackage, WP6. The task is to organize the project and manage the general aspects of the project, e.g. its dissemination towards the organic sector and the Danish public sector in general.

A steering committee will be formed consisting of one representative of each partner. The steering committee will meet (probably "Skype meetings") at least once a year at the time of status reporting, and meet ad hoc or discuss by e-mail when necessary.

A stakeholder network will be identified consisting of 20-40 stakeholders. Short electronic newsletters will be sent to them 2-4 times a year, to give information on important activities in the project and the public meetings/open field days we arrange, and to encourage them to give feedback to us. The stakeholder network will include magazines hoping that they will write about the project work.

The "project unit" at KU-IJØ will be included to assist communication with the stakeholder network and project partners and collection and organization of information from partners e.g. for status reporting.

Meetings for the whole research group of the project will be organized at least three times during the project period.

A12.10. The technical competences of the partners and their contribution to the project including how they complement each other (max. 5 lines per partner).

University of Copenhagen, LIFE, Dept. of Agriculture and Ecology, Crop Science Section:
Extensive research competences on crop root growth and nitrogen use efficiency of crops and of whole rotations, and of catch crops, green manure, and on simulation modelling of soil and crop nitrogen dynamics incl. the extension model NDICEA. Experience as project leader of previous interdisciplinary projects within organic farming. Activities: Project management (WP6), main responsible for root growth (WP1) and contributions to system analysis and model work in WP4 (Kristian Thorup-Kristensen and PhD NN).

University of Copenhagen, LIFE, Dept. of Agriculture and Ecology, Plant and Soil Section:
Extensive research experience with agricultural manures, crop residues and urban waste products, their quality, utilisation, treatment (incl. composting) and effects on soil nutrient cycling, soil quality and losses of N and P to the environment. Also competences on simulation modelling, environmental impact and life cycle assessment in agricultural systems. Activities: Main responsible for WP2 and associated activities (Jakob Magid, Lars Stoumann Jensen, Post-doc NN).

VFL - The Danish Knowledge Centre for Agriculture:
Extensive experience and expertise in advising farmer, developing advisory tools, and conducting development projects, and it is in close cooperation with advisory service centres in other countries. VFL is responsible highly experienced in conducting field trials at farms. Activities: VFL is main responsible for WP4 and will collect and present methods for assessment of agricultural production. VFL is responsible for the field trials with wheat, onion and lettuce in 3.

Økologisk Landsforening (Organic Denmark):
Økologisk Landsforening is an organization representing farmers, companies and consumers interested in organic farming, and working to develop the organic sector based on the many different interests in organic farming. They have worked with phasing out the use of manure from conventional farms, and how to reconcile such basic ideas with the reality at organic farms. Activities: Work in WP5 on defining questions for focus group studies and implementing the results in their work on regulations of organic farming.

KomTek Miljø A/S (KomTek Environment Ltd.):
KomTek is specialised in converting organic waste into quality soil conditioners, organic fertilizers, growth media for e.g. agriculture and horticulture, and into bio-fuels. Komtek operates one of Denmark's largest composting facilities, and has an annual turnover of +30 mio DKK. The company spends significant resources on develo¬ping new products, and has experience with university research collaboration. Activities: WP2 participant, producer of specifically designed compost products (Man. Director Bjarne Larsen).

Solum A/S (subsidiary of Solum Group)
The Solum Group comprises a number of companies in Denmark, Norway and Sweden, incl. Solum A/S, whose activities are focused on processing of organic residues and knowledge of biological processes. Solum A/S converts around 200,000 tonnes of organic waste per year into energy, high quality growth media and organic fertilizers. Focus is on conservation of nutrients and organic matter and on safe and high quality products. Activities: WP2 participant, consultancy and advice (Tech. Dir. Morten Brøgger).

Univ. Copenhagen, Dept. Food and Resource Economics, Consumption, Health and Ethics section
Extensive research competences within public and other stakeholders' perceptions of food and food related technologies. Has wide experience with qualitative sociological methods such as focus group interviews, individual interviews and argument analysis. Has long experience as daily manager of a number of sociological

subprojects in larger interdisciplinary (national as well as EU) research projects. Activities: Main responsible for sociological studies of perceptions among organic farmers and consumers (WP5).

A12.11. Expected collaboration with other research institutions/companies nationally and internationally (max. ½ page). As mentioned elsewhere and shown in Appendix 3 and 4, we plan to cooperate with the major bakery company Lantmännen who is already working to develop their line of organic bread products, and with Aarstiderne A/S, a major supplier of organic vegetables and other products through the largest box scheme in Denmark.

No further cooperations with companies or research institutions are planned in the RoCo project so far. However, many of the participants in RoCo have extensive international cooperations in other projects, some of which will be of value also for the RoCo project. One obvious example is the EU FP7 project "NUE-Crops" working on breeding nutirent efficient cultivars of wheat, rape seed, potatoes and maize. Kristian Thorup-Kristensen is a partner in this project, which run from 2009 until 2014, i.e. overlapping all of the planned project period for RoCo.

A12.12. The relation to previous projects within the projects focus areas (if any) including references to these (max. ½ page). The project build on knowledge and expertice gained from many previous projects, among them several FØJO (ICROFS) projects and EU projects. The ongoing FØJO III project VegQure, the FØJO II project VegCatch and other FØJO projects with particiants from the RoCo group of researchers (Kristian Thorup-Kristensen, Lars Stoumann Jensen, Jakob Magid and Ulla Kidmose) have dealt with many aspects of crop root growth, nutrient turnover and efficiency, reduced dependency on manure import, rotation optimization with catch crops and green manure and effects on product quality. Kristian Thorup-Kristensen has been project leader five FØJO projects dealing with various aspects of improved nutrient management in organic crop production mainly focussing on vegetable crops.

Also EU projects including the FP6 project QLIF (QualityLowInputFood) have contributed to the basis for the work suggested in RoCo, through work on rotation optimization, modelling of nutrient turnover and crop growth and on effects of low-input farming systems on food quality. From our CVs further relevant research projects and topics that we worked with can be seen.

A13. Tables with milestones and deliverables with information as requested in the table in A16.
See table A16 below.

A14. List of deliverables from the project (also fill out the table in A17)
See table A17 below.

A15. List of appendices
Appendix 1: List of litterature cited in application
Appendix 2: CV of participants
Appendix 3: Lantmännen R&D: Declaration of support and dedication of ressources for participation in RoCo
Appendix 4: Aarstiderne A/S: Declaration of support and and interest to participate in RoCo

A16. Milestones and time schedule for the entire project

wp no.	Milestone no.	Title/activity	Responsible project participant	Date/year	Other participants
1	1.1	First year screening of root traits of genotypes of wheat, onion and lettuce finished	KU-IJØ	Dec 2011	
1	1.2	Cultivars selected for field studies in WP3	KU-IJØ	Jan 2012	VFL
1	1.3	Characterization of root hair profiles of seedlings of wheat and lettuce	KU-IJØ	Apr 2012	
1	1.4	Second year screening of root traits of genotypes of wheat, onion and lettuce finished	KU-IJØ	Nov 2012	
1	1.5	Pot trials with cultivars grown in nutrient depleted soil finished	KU-IJØ	Nov 2012	
1	1.6	First year testing of selected genotypes at low nutrient availability	KU-IJØ	Nov 2012	
1	1.7	Second year testing of selected genotypes at low nutrient availability	KU-IJØ	Nov 2013	
2	2.1	Collection of materials and initiation of 1st composting	KomTek	May 2011	KU-IJØ
2	2.2	Collection of materials and initiation of 2nd composting	KomTek	Dec 2011	KU-IJØ
2	2.3	Assessment of granular compost for high precision use (fertilizer placemnt)	KU-IJØ	Dec 2011	KomTek
2	2.4	Assesment of seedling block compost	KU-IJØ	Jun 2012	KomTek
3	3.1	1st year field trials has been completed, wheat samples delivered for baking studies	VFL	Dec 2012	AU-IFK
3	3.2	Baking quality studies from 1st year field trials has been completed	AU-IFK	May 2013	Lantmännen
3	3.3	Baking studies with alternative ingredients has been completed	AU-IFK	May 2013	Lantmännen
3	3.4	2nd year field trials has been completed, wheat samples delivered for baking studies	VFL	Nov 2013	AU-IFK
3	3.5	Baking quality studies from 2nd year field trials has been completed	AU-IFK	Nov 2013	Lantmännen
4	4.1	Identify and make agreement with organic farmers to host wheat experiments in 2012 and 2013	VFL	Aug 2011	KU-IJØ
4	4.2	Case simulations with the NDICEA model, optimzation of rotations with composts,	VFL	Oct 2012	KU-IJØ

		catch crops and green manure			
5	**5.1**	**Interview guides for farmer and consumer interviews developed**	**KU-FOI**	**Jun 2011**	**ØL and KU-IJØ**
5	**53**	**Interviews with farmers and consumers carried out**	**KU-FOI**	**Dec 2012**	**ØL**
5	**5.3**	**Farmer interviews analysed and reported to the project**	**KU-FOI**	**Apr 2012**	
5	**5.4**	**Consumer interviews analysed and reported to the project**	**KU-FOI**	**Aug 2012**	
6	**6.1**	**Steering committee established, 1st meeting**	**KU-IJØ**	**Apr 2011**	**All partners**
6	**6.2**	**Stakeholder network partners identified and network established**	**KU-IJØ**	**June 2011**	**All partners**
6	**6.3**	**First newsletter submitted**	**KU-IJØ**	**June 2011**	**All partners**

A17. List over deliverables (D=deliverables) for the entire project, stating whether the deliverable belongs to the research part of the project (R); the development part (D); and/or demonstration (Dm).

D. no.	Deliverable	Responsible project participant	Date/year	R, D, or Dm Effective working time, months [1]	Type of deliverable*
1.1	Scientific paper on cultivar variation in root traits of wheat, onion and lettuce	KU-IJØ	Apr 2013	R - 16	S1
1.2	Scientific paper on root hair profiles and nutrient depletion from soil under 2D constraints	KU-IJØ	Apr 2013	R - 16	S1
1.3	Scientific paper on early topsoil exploitation by cultivars of onion and lettuce varying in root system architecture	KU-IJØ	Oct 2013	R - 12	S1
1.4	Popular paper on variation in root growth among onion and lettuce cultivars	KU-IJØ	Sep 2013	D - 1	P1
1.5	Popular paper on variation in root growth among old and new wheat cultivars	KU-IJØ	Nov 2013	D - 1	P1
1.6	Scientific paper on variation in field root growth of wheat cultivars and their adaptation to low nutrient availability	KU-IJØ	Dec 2013	R - 12	S1
1.7	PhD thesis on variability in root growt and architecture of crop cultivars of wheat, onion and lettuce	KU-IJØ	Dec 2013	R - 12	C1
2.1	Semigranular composts for trials in WP1 and WP3	KomTek	Sep 2011	D - 2	
2.2	Compost based seedling blocks	KomTek	Apr 2012	D - 2	
2.3	Improved semigranular composts for WP1 and WP3	KomTek	Sep 2012	D - 2	
2.4	Improved compost based seedling blocks	KomTek	Apr 2013	D - 2	
2.5	Report on improved compost products	KU-IJØ	Sep 2012	D - 1	P1
2.6	Scientific paper on improved compost products	KU-IJØ	Apr 2013	R - 6	S1
3.1	Scientific paper on effects of alternative ingredients on baking with low-protein wheat	AU-IFK	Oct 2013	R - 12	S1
3.2	Scientific paper on baking quality of organic wheat as affected by cultivar and nutrient supply	AU-IFK	Dec 2013	R/D - 12	S1
3.3	Popular paper on baking quality of organic wheat	AU-IFK	May 2013	D - 1	P1
3.4	Knowlegde transfer from AU-IFK to the baking industry (workshop with oral presentations)	AU-IFK	Sep 2013	D - 2	P1+P2
4.1	1st year open field days on the wheat and vegetable experiments	VFL	Jun 2012 to Aug 2012	Dm - 1	P2
4.2	Paper on NDICEA simulated model studies of optimized rotations	VFL	Sep 2012	Dm - 4	P1

[1] The total amount of months must be consistent with the total number of months in the budgets, and will therefore show the relative working effort per work package.

4.3	**Field course for advisors in organic farming**	**VFL**	**Jun 2013**	**Dm - 4**	**P1+P2**
4.4	**Published NDICEA guide for Danish organic farm advisors**	**VFL**	**Apr 2013**	**Dm - 2**	**P1**
4.5	**Popular papers on field trials and optimization of rotations**	**VFL**	**2012 to 2013**	**Dm - 1**	**P1**
4.6	**Presentations at "Danish organic congress" or NJF**	**VFL**	**2013**	**Dm - 2**	**S4**
5.1	**Popular paper on consumer and organic farmer attitudes to recirculation of urban nutrient sources**	**ØL**	**Sep 2013**	**DM - 1**	**P1**
5.2	**Meetings with members and other relevant partners on development of regulations of nutrient recirculation**	**ØL**	**Oct 2013**	**D - 3**	**P2**
5.3	**Scientific paper on consumer and organic farmer attitudes to recirculation of urban nutrient sources**	**KU-FOI**	**Dec 2013**	**R/D - 10**	**S1**
6.1	**Yearly status reports**	**KU-IJØ**	**Each year**	**? - 2**	
6.2	**Final report**	**KU-IJØ**	**2014**	**? - 1**	

* Fill in the type of deliverable. Use the List of type of deliverables on the last page in Annex 3 “Instructions for filling in the application form”.